

Developments in Leach Testing

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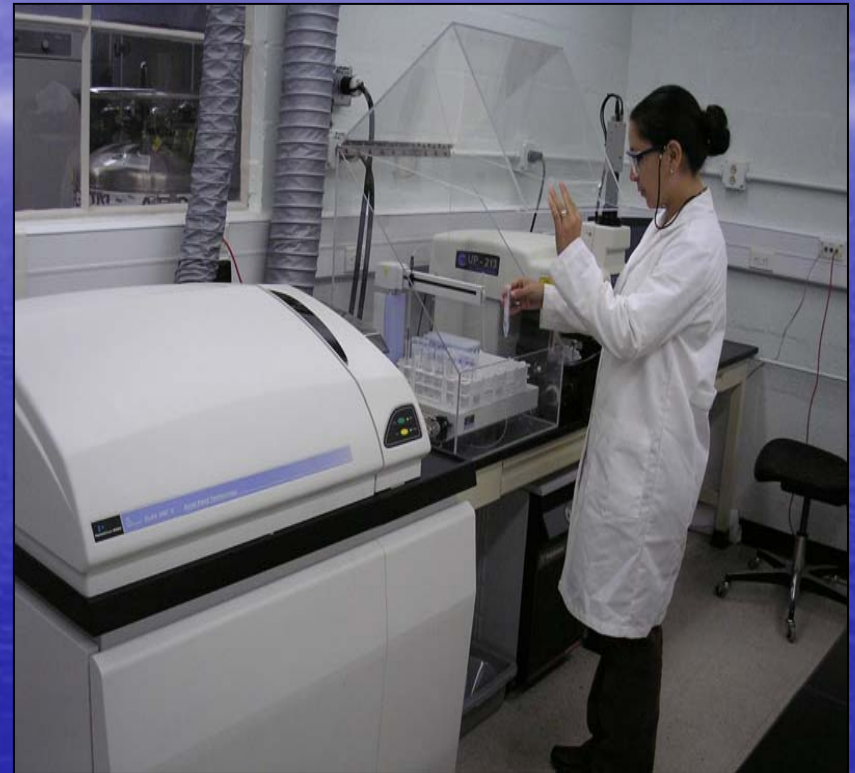
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Outline

- RCRA Background
- TCLP – Concerns & Issues
- EPA's Response to Concerns
- Leach Testing of Coal Combustion Residues (CCRs)
- Next Steps in Leach Test Development
- Conclusions



RCRA Background

- EPA regulates waste management under the Resource Conservation and Recovery Act (RCRA)
- Groundwater contamination is a key waste management concern
- Leach testing has been used in regulatory programs to help determine:
 - What waste is hazardous: listings, delistings, Toxicity Characteristic (TC) regulation
 - What treatment is adequate: Land Disposal Restriction (LDR) treatment requirements
- TCLP is the most used leaching test.

RCRA Background

- TCLP was designed as a screening test to consider leaching under conditions that may be present in a MSW landfill:
 - Acetic acid buffered to pH 5 (initial);
 - 20:1 liquid/solid ratio;
 - particle size reduction to 9.5 mm;
 - equilibrium.
- Co-disposal of industrial solid waste with MSW is considered to be plausible “worst case” management of unregulated waste.

RCRA Background

- TCLP Use in RCRA:
 - Toxicity Characteristic (TC) regulation (40 CFR 261.24):
 - TCLP is part of the regulation, so TCLP results determine compliance.
 - LDR waste treatment regulations (40 CFR 268.40, 268.48):
 - Most metals LDR treatment levels are based on leaching from S/S treated waste.
 - TCLP was used to determine leaching potential, so TCLP results determine compliance for these.
 - Treated TC waste can be MSW co-disposed so TCLP is relevant; HW landfill conditions vary, and may be similar to some MSWLF conditions.

RCRA Background

- Radiological waste is not regulated under RCRA (RCRA Section 1006).
 - However, some radiological wastes may also exhibit a hazardous characteristic, such as the toxicity characteristic.
 - These are termed “mixed wastes” under RCRA, and are regulated under RCRA and other applicable statutes.
 - Some NRC mixed waste is conditionally exempt from RCRA (66 FR 27218, May 16, 2001).

RCRA Background

- Because of its regulatory program use, TCLP is also used when not required:
 - Evaluation of non-hazardous waste being reused
 - state Beneficial Use programs;
 - recent federal proposal to reuse Chat
 - Industrial non-hazardous waste landfills
 - Site remediation: evaluation of treatment effectiveness (including in-situ treatment) where LDR regulations are not triggered

EPA Science Advisory Board (SAB) Concerns Re: TCLP

- The SAB commented on Agency leach testing in 1991 and 1999.
 - The SAB expressed concern about over-broad use of the TCLP test.
 - SAB urged the Agency to undertake new leaching research on both occasions.
 - SAB urged development of tests that consider actual disposal conditions affecting leaching.
 - SAB urged field validation of new tests.

Program Problems in TCLP Use

- In 1997 EPA found it necessary to withdraw a delisting granted to Reynolds Aluminum:
 - Treated spent potliner (K088) was delisted in 1991, and monofilled onsite
 - The monofill generated leachate with pH 12.5-13.5
 - As leachate concentrations were 100x the levels predicted by TCLP

Program Problems in TCLP Use

- EPA's LDR standard for K088 was also based on TCLP data:
 - Columbia Falls Aluminum Co. brought a lawsuit challenging the LDR standard based on the delisting data
 - EPA lost the lawsuit:
 - The court found that the actual management conditions were so different from TCLP that TCLP could not be used to determine compliance with the LDR regulation.

Review of leach Test Use

- TCLP is a screening test that evaluates leaching potential under a single set of environmental conditions:
 - Initially acidic conditions; final conditions were not considered critical; usually are not known
 - Generally oxidizing environment
- For most metals, leaching is pH dependent.

Review of leach Test Use

- Reviewed TCLP use:
 - Found it works well in its intended use: screen for TC waste determinations where MSW codisposal is plausible
 - Some problems with assessing arsenic leaching (even under MSW conditions)
 - Hooper et.al. 1998; Ghosh et.al., 2004
 - Some problems with high iron content waste
 - Reducing conditions can increase leaching
- No EPA plans to replace or revise TCLP

EPA Response to Concerns

- Where TCLP use is not required by regulation, EPA has broadened its use of leaching tests:
 - Delisting guidance: revised delisting guidance urges leach testing at acid, alkaline, and neutral (waste determined) pHs
 - Broadened use of leach tests in hazardous waste listing determinations
 - Used TCLP and SPLP in inorganic chemicals listing
 - Used multi-pH testing in chlorinated aliphatics listing
 - Identified alternatives to TCLP for use with Industrial D Guidance for management of non-hazardous wastes

EPA Response to Concerns

- The Agency has also been seeking new testing approaches with:
 - Better accuracy over a range of conditions
 - Better foundation in basic science (i.e., not empirical)
 - Better applicability in environmental assessments (i.e., groundwater fate and transport modeling)
 - Flexibility to apply to a broad range of waste types and over a range of conditions that affect leaching and occur in management

EPA Response to Concerns

- Consideration of factors that affect leaching:
 - Waste form
 - pH (waste generated and external)
 - Infiltration
 - Redox conditions
 - others
- Validation in both the lab and field
- Practical applicability of tests

EPA Response to Concerns

- Seeking approaches to be developed into reliable tests for routine use:
 - Much non-TCLP testing has been research or *ad hoc* modifications of TCLP
 - Need defined protocols that are validated; Validation includes interlab and field evaluations
 - Most existing alternatives have not been validated (particularly field validation)

Leach Testing of CCRs

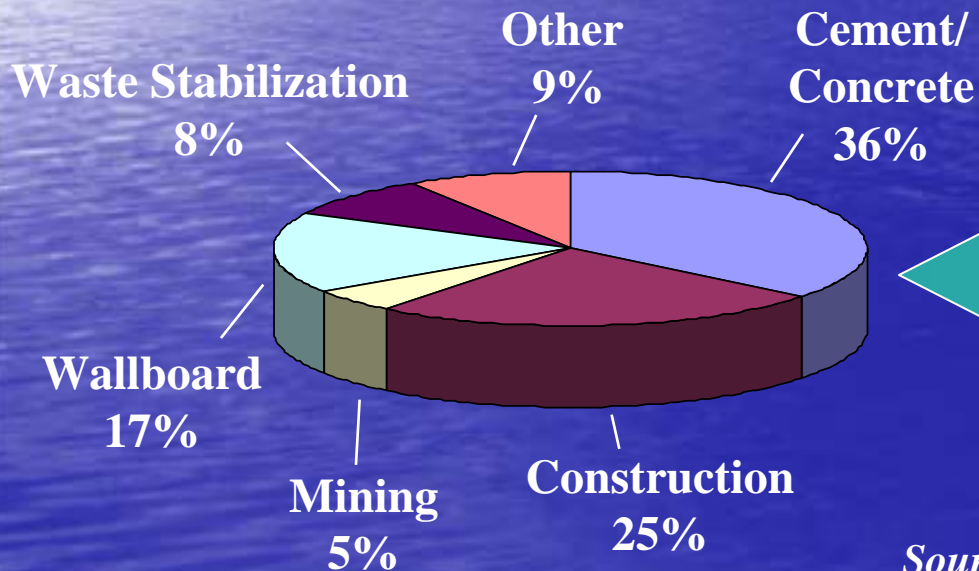
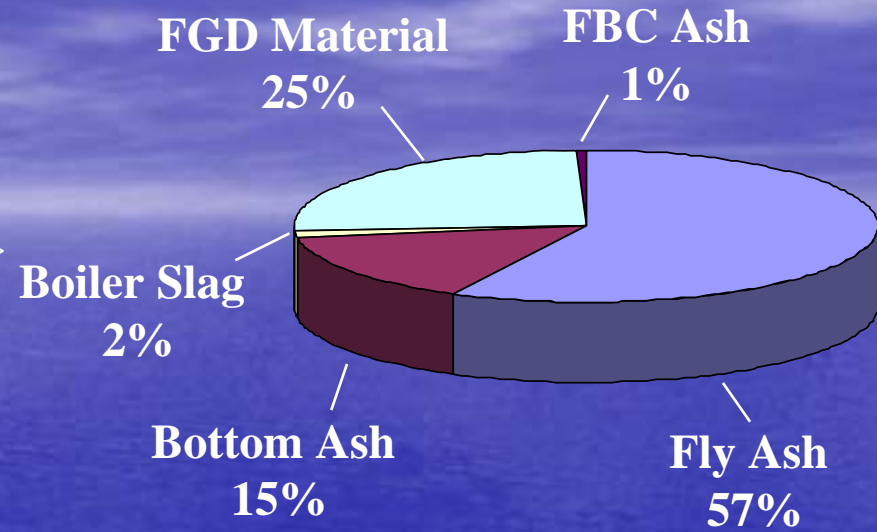
- EPA is currently evaluating leaching from CCRs resulting from mercury emissions controls.
 - Testing for leaching of Hg, As, Se, and other metals
- A leach testing approach developed by Kosson, et.al (2002) is being used:
 - Kosson, Van der Sloot, Sanchez and Garrabants. (2002). An Integrated Framework for evaluating Leaching in Waste Management and Utilization of Secondary Materials. Environmental Engineering Science, Vol 19(3),159-204

Leach Testing of CCRs

- The Kosson Framework addresses many EPA program needs and SAB concerns:
 - Considers factors known to affect leaching of metals:
 - pH (solubility of many metal salts change with pH)
 - L/S ratio (or infiltration rate)
 - Form of waste (granular, compacted, or monolithic)
 - So, better accuracy expected
 - Tiered and flexible
 - Can test both worst-case and more realistic cases
 - For small volumes, do conservative and cheaper testing
 - Outputs can be used with site conditions data to generate probabilistic leaching estimate.
 - Probabilistic leach estimate most appropriately drives groundwater transport modeling.

CCR Production and Utilization

**Production
122 million tons**



**40% Utilization
49 million tons**

Source: ACAA 2004 CCR Survey; DOE, 2005

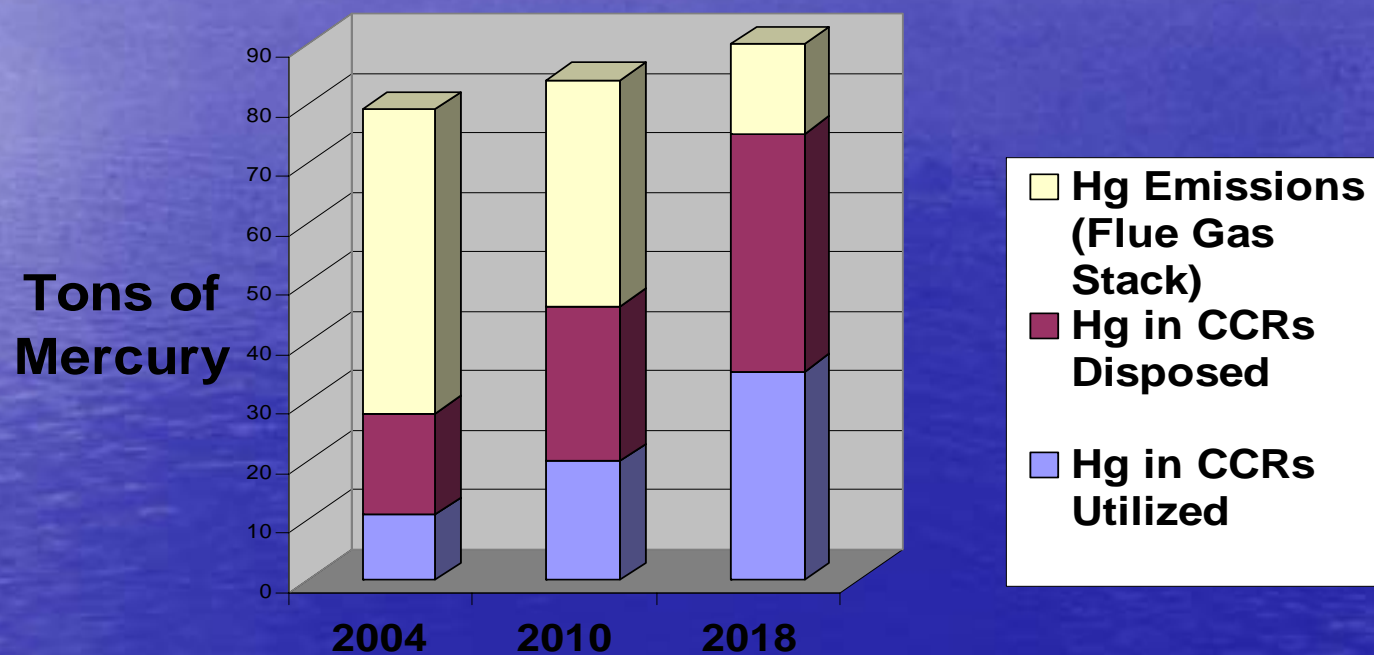
Concern for Providing Full Characterization of reuse materials

- Recent National Academy of Science (NAS) report on CCR use in mine filling stated that full characterization should not be cut short *“in the name of beneficial use”*.
- Historically, CCRs are an area of focus because of their wide range of potential beneficial use applications
 - Since 1991, CCR utilization increased from 31 to 40%.
 - A goal of EPA's Resource Conservation Challenge is to increase CCR utilization to 50% by 2010.

EPA Research Objectives

- Evaluate impact of air pollution control on coal combustion residues (CCRs)
- Identify potential cross-media transfers of mercury and other metals from CCR management which includes FGD gypsum and fly ash
- Compare life-cycle environmental tradeoffs from use of CCR and non-CCR materials

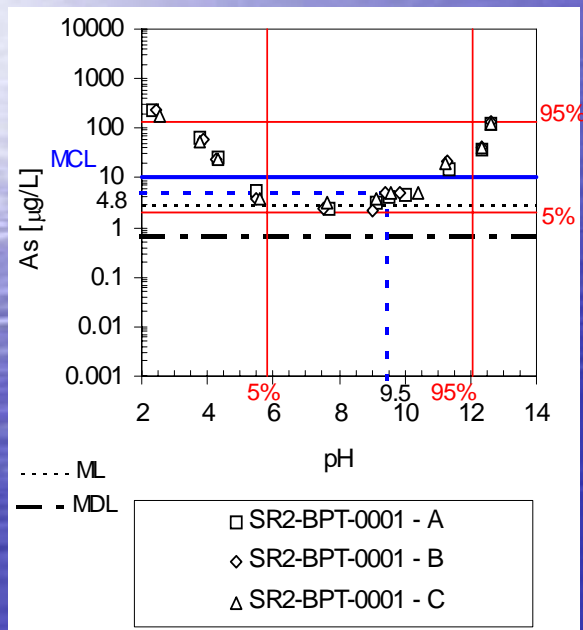
Projection of Hg Mass Balance in Response to CAIR and CAMR Implementation



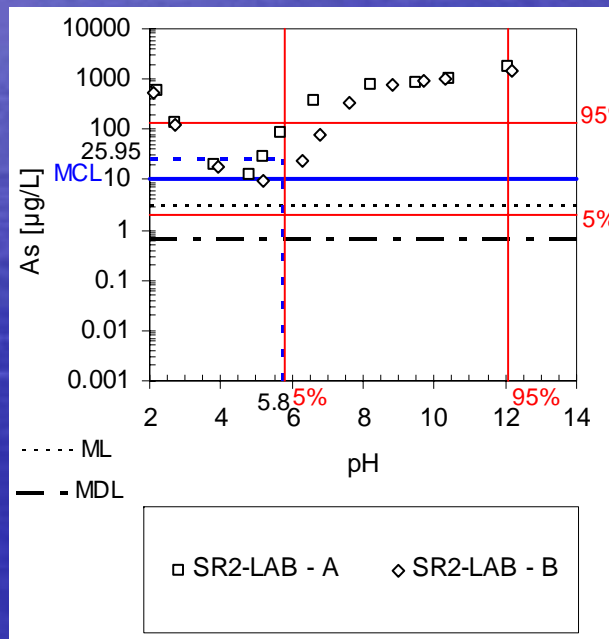
Source: Thorneloe, 2006

Arsenic Leaching as a Function of pH

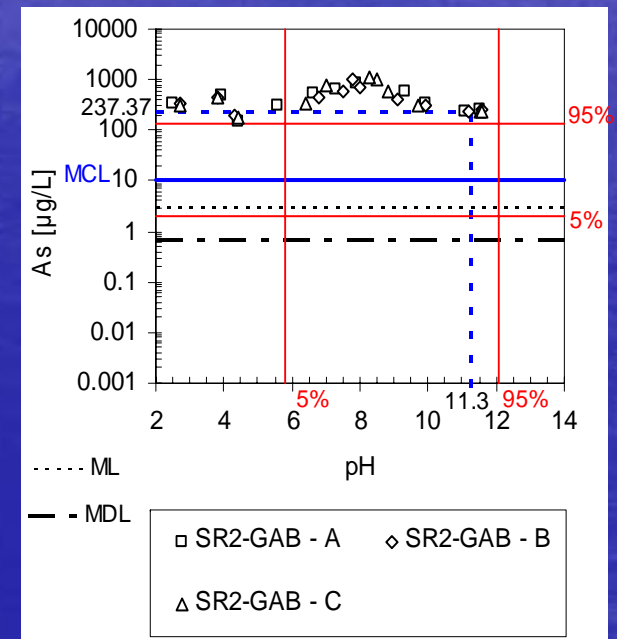
Brayton Point



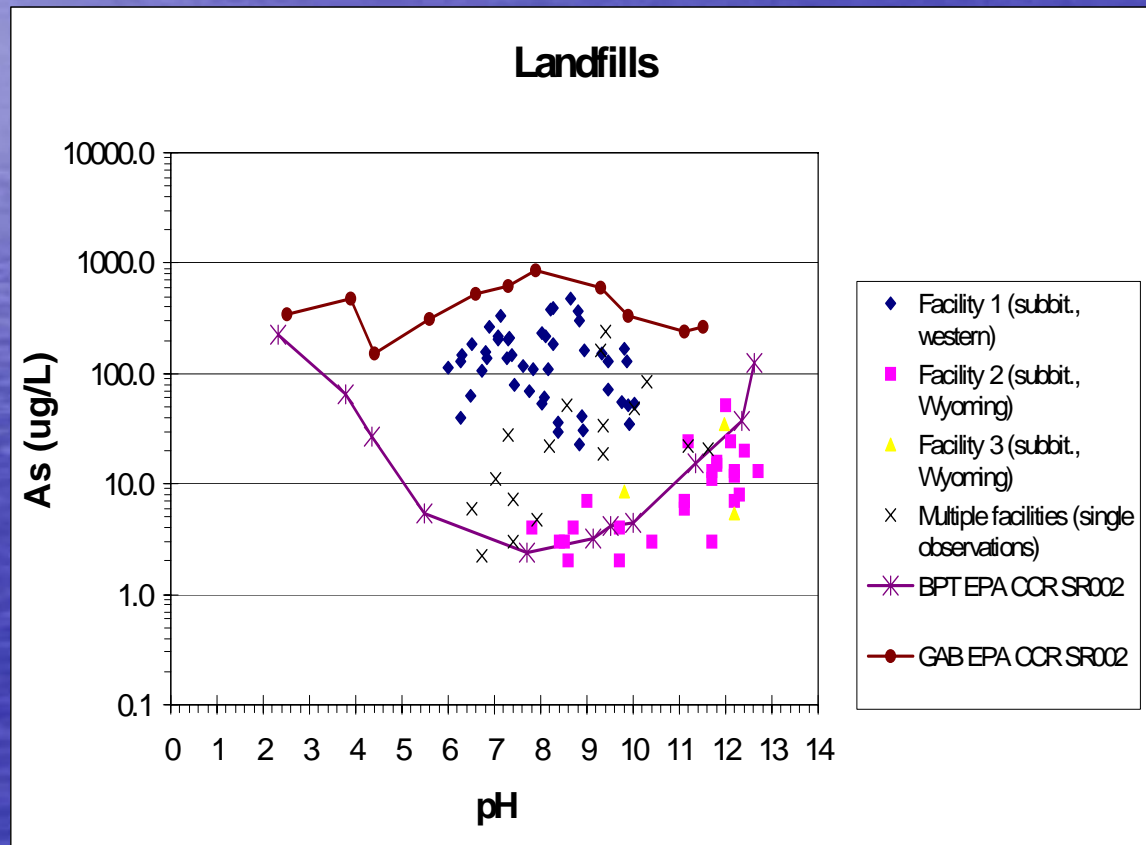
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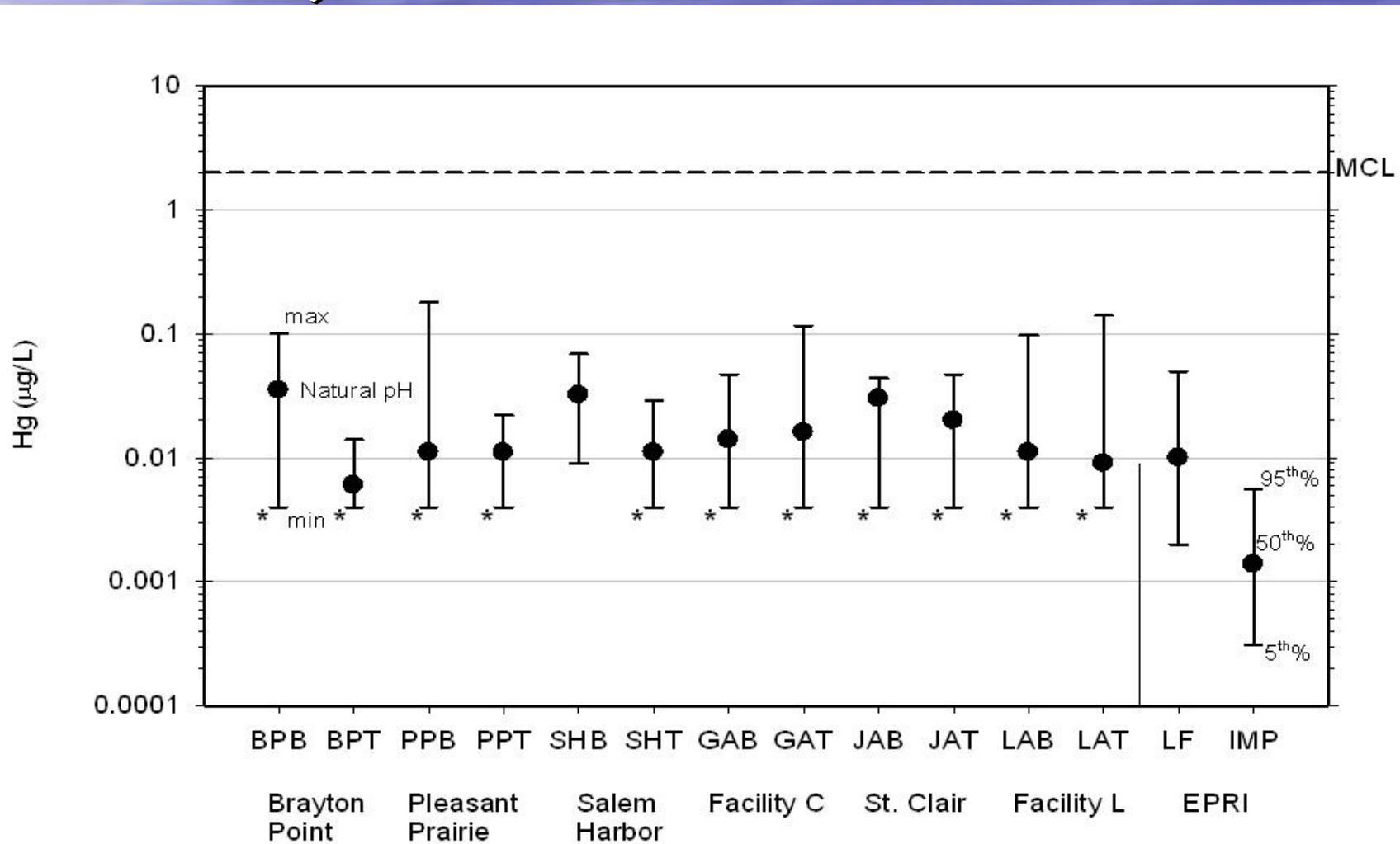
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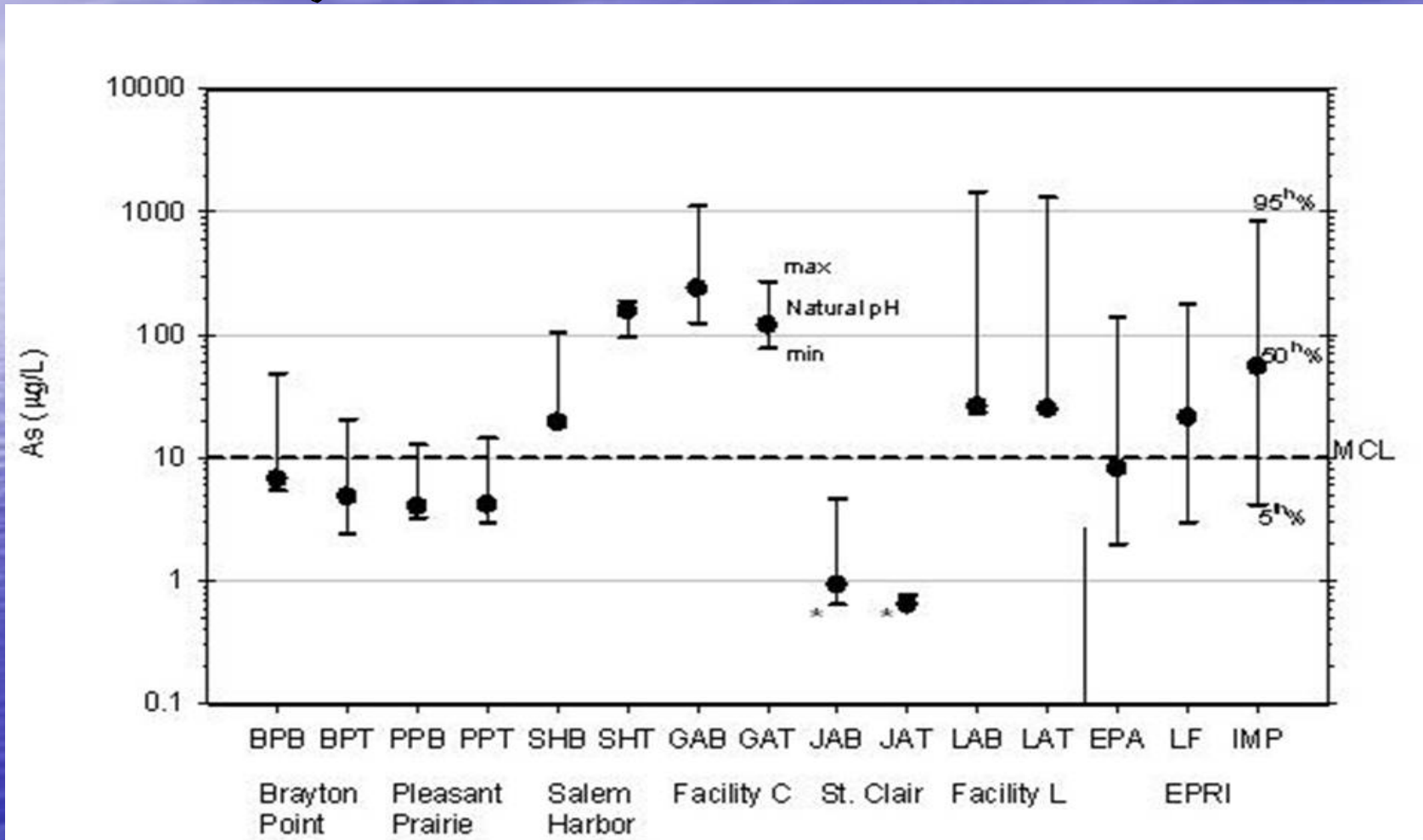
Landfill Arsenic Leachate Data (Field vs. Laboratory Leachate Comparison using EPRI and EPA data)



Ranges of Hg Leachate Concentrations (From Report 1 on Use of Enhanced Sorbents)



Ranges of As Leachate Concentrations (From Report 1 on Use of Enhanced Sorbents)



Results for Leach Testing Analysis for Coal Fly Ash From Facilities Using Sorbents for Enhanced Hg Capture

Metal -	Hg	As	Se
Total in Material (mg/kg)	0.1 -1	20 - 500	3 - 200
Leach results (ug/L)	Most 0.1 or lower	<1 - 1000	5 – 10,000
MCL (ug/L)	2	10	50
TC (ug/L)	200	5,000	1,000
Variability relative to pH	Low	Moderate to High	Moderate

MCL - Maximum concentration limit (for drinking water)

TC – Toxicity Characteristic – above the TC, material is considered a hazardous waste

Leach Testing Approaches

- Supportive consultation with SAB in 2003:
 - SAB reviewed the Kosson framework for assessment of leaching from CCRS and general waste re-use
 - SAB panel considered the framework broadly applicable to waste assessment, esp. inorganics
 - SAB urged further development of relationship to field data, interpretation of data for decision making
 - SAB urged further development to include organics leaching and microbial effects on leaching
 - More information at the SAB website:
<http://www.epa.gov/sab/eeconsultationonleaching.html>
 - Kosson Framework publication available at SAB website

Leach Testing Approaches

- Why not other existing leaching tests?
 - Not field validated
 - Don't consider environmental conditions of waste management
 - Don't try to relate test results to environmental releases (i.e., assess leaching "under the conditions of the test")
 - Don't robustly support current probabilistic groundwater fate and transport modeling

Field Validation Work

- EPA is continuing and broadening field validation of this approach:
 - Additional paired waste/field leachate samples
 - Review of literature for useful data
 - Collaboration with EU researchers doing parallel work.
- If successfully validated, develop the approach into SW-846 method.

Conclusions

- TCLP is an appropriate and reliable test for its intended purpose: as a screening test for waste that may be disposed in an MSWLF or similar conditions.
- Where disposal conditions are known and are different from MSWLF, tests tailored to those conditions will better identify waste leaching potential as a scientific matter.
- However, incorporation of new science into regulatory programs takes time.

Conclusions (Cont.)

- State organizations including the Assn of State and Territorial Solid Waste Mgmt Officials have requested that EPA develop leach test protocols that will assist in helping to make more transparent and consistent decisions for beneficial use decisions.
- EPA is interested in collaborating with DOE in establishing more applicable leach testing protocol including validation and interlaboratory comparisons.

Contact Information

- For further information on regulatory background and leach test development, contact Greg Helms at Helms.Greg@epa.gov
- For further information on application of leach testing framework to evaluate impact of changes to air pollution control at coal-fired electric utilities on fly ash and other air pollution control residues, contact Susan Thorneloe at Thorneloe.Susan@epa.gov

Questions?

